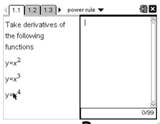
3.3a Rules for Differentiation

Use Power Rule.tns to discover the power rule for derivatives



$\frac{d}{dx}x^2 = 2x$

$\frac{d}{dx}x^3 = 3x^2$

$\frac{d}{dx}x^4 = 4x^3$

$$\boxed{\frac{d}{dx}x^n = nx^{n-1}}$$

power rule

$\frac{d}{dx}5x^4 = 20x^3 = 5\cdot 4x^3$

$$\boxed{\frac{d}{dx}\left(k\cdot f(x)\right) = k\cdot f'(x)}$$

constant multiple rule

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Proof of the power rule $\frac{d}{dx}(x^n) = nx^{n-1}$

1
1 1
1 2 1
1 3 3 1

$$\lim_{h\to 0}\frac{(x+h)^n - x^n}{h}$$

$$\lim_{h\to 0}\frac{\left(\cancel{x^n} + nx^{n-1}h + c_2x^{n-2}\cdot h^2 + \cdots + h^n\right) - \cancel{x^n}}{h}$$

$$\lim_{h\to 0}\frac{\cancel{h}\left(nx^{n-1} + c_2x^{n-2}\cdot \underbrace{h}_{\to 0} + \underbrace{\ldots}_{0} + \underbrace{h^{n-1}}_{\to 0}\right)}{\cancel{h}} = nx^{n-1}$$

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Find $\frac{dy}{dx}$ if $y = x^3 + 6x^2 - \frac{5}{3}x^1 + 16\cdot x^0$

$$\frac{dy}{dx} = 3x^2 + 12x - \frac{5}{3} + 0$$

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Find the horizontal tangents of $y = x^4 - 2x^2 + 2$

slope = 0

by hand

$y' = 4x^3 - 4x = 0$ solve for x

slope of tan line

$4x(x^2-1) = 0$

$4x(x+1)(x-1) = 0$

$x=0 \quad x=-1 \quad x=1$

$y=2 \quad y=1 \quad y=1$

with the calculator

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higher order derivatives

$y = x^3$

$y' = 3x^2$

$y'' = 6x$

$y''' = 6$

$y^{(4)} = 0$

$y^{(5)} = 0$

$\vdots$

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